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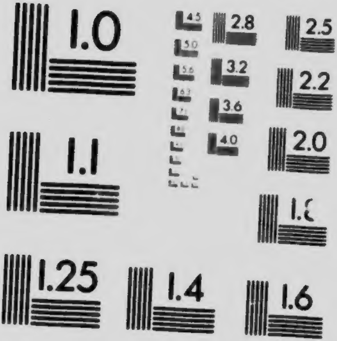

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Geological Survey

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A BEATRICEA-LIKE ORGANISM FROM THE MIDDLE ORDOVICIAN

by

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A Beatricea-like Organism from the Middle Ordovician.

By PERCY E. RAYMOND.

Species of *Beatricea* have long been known from the Richmond formations of Anticosti, the Manitoulin islands, Manitoba, and Kentucky, but until very recently it was not suspected that this type of organism occurred in any older strata. In a paper by George W. Stose on the "Cambro-Ordovician limestones of the Appalachian Valley in Southern Pennsylvania,"[1] Ulrich has listed *Beatricea* n. sp. as being very common in the Lowville. In later papers the name *Beatricea gracilis* was given to this species by Ulrich, but so far as I know, no description has yet been published. Through the kindness of Dr. Bassler, of the United States National Museum, I have been able to see specimens purporting to be *Beatricea gracilis*, and from them it would appear that the form so named is much more slender than the species about to be described. The material which I have seen showed no internal structure, and was not suitable for sectioning, and it is, therefore, impossible to make any real comparison with *Beatricea gracilis* at the present time.

The specimens about to be described were found just below the range of *Tetradium cellulosum* and *Bathyurus extans*, and, therefore, just below the base of the Lowville. The writer's first acquaintance with these fossils was in the autumn of 1910, when he found a bed containing great numbers of them on the hill north of Aylmer, Que., in the highest layer of the formation which underlies the Lowville. Although abundant, all the specimens were so badly preserved that they were at first thought to be "sea-weeds" or other indeterminable objects, until finally a single weathered specimen containing septa (Plate III, figure 2) was obtained. Being then unaware of Ulrich's finds in Pennsylvania, the writer believed he had been the first to extend the geological range of these *Beatricea-like* forms, but soon came upon Ulrich's list in Stose's paper. Further investigation revealed the presence of these fossils both in and below the Lowville at Mechanicsville, on the Ontario side of the river near Ottawa. These occurrences, listed as "*Beatricea* sp." were noted in a paper in the Ottawa Naturalist for February, 1911.[1]

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[1] Journal of Geology, Vol. 16, 1908, p. 714.

In June, 1911, the writer had an opportunity of visiting northern New York, and there, at the top of the Upper Pamelia and just below the Lowville, found the layer containing the same organisms at a number of places south of Clayton. About the same time, Mr. W. A. Johnston, of the Geological Survey, to whom I had shown my specimens, sent in from the field specimens much better than any I had found. They were obtained, as usual, from strata just below those containing *Tetradium cellulosum* and *Bathyurus extans*, and the locality is near a wood road along the northern fence of lot 25, concession VI, of the town of Carden, east of Lake Simcoe, Ontario, about 150 miles west of the localities near Ottawa. This locality was visited again later in the year by Mr. Johnston and the writer, in 1912 by Mr. E. J. Whittaker, and a second time by the writer in 1913, so that a considerable amount of material has been accumulated. A list of the fossils from this locality so far determined was published by Mr. Johnston in the Summary Report of the Director of the Geological Survey of Canada for 1911 (1912), page 255. The most striking fossils are a remarkable *Tetradium* (*T. halysitoides* Raymond), *Onchometopus simplex* Raymond and Narraway, and *Bathyurus johnstoni* Raymond. On the basis of these species, which have been found by the writer both at Ottawa and in northern New York at this same horizon just

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[1] Preliminary Notes on the "Chazy" Formation in the vicinity of Ottawa. Ottawa Naturalist, vol. 24, p. 193, 1911.

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below the Lowville, these beds are correlated with the upper part of the Pamelia formation of New York.

At the locality in Carden, the *Beatricea-like* fossils are found on the weathered surfaces of the flat-lying strata, and have the form of long, narrow chambered tubes. They have the general appearance of cephalopods, but are easily distinguished from them because they do not taper appreciably, though some specimens are 18 inches long, the chambers are of irregular depth, there is no siphuncle, and while usually nearly straight, many of the specimens are irregularly or abruptly curved. Most of the specimens lie parallel to the bedding planes, and are usually incomplete; but some are found which were buried in a vertical position and on cutting and polishing these, some are found to preserve a good deal of their original structure.

It will be remembered that *Beatricea* is one of those unfortunate genera whose systematic position has not been satisfactorily determined. Originally described by Billings,[1] these fossils have been called plants, foraminifera, rugose corals and cephalopods, and at last have found a resting place as a family among the Stromatoporoids, this position having been fixed for them by Nicholson.[2]

DESCRIPTION OF THE SPECIMENS.

This fossil has a long flexuose, cylindrical form of unknown length, only the upper termination having been seen. Fragments from 12 to 18 inches long are not uncommon. The diameter appears to be approximately uniform throughout the length of the fragments observed. Most of the specimens are from 10 to 20 mm. in diameter, but as will be hereafter shown, this does not show the true thickness of the fossil, as in nearly all specimens a part has failed of preservation. No well preserved outer surface has been seen, but from the evidence of sections of embedded specimens, it would appear that the surface is covered with small papillae. Sections perpendicular to the long axis show that the fossil is made up of concentric zones of very different structure. The inner zone seems to consist of a tube with a definite wall, this tube being divided by deeply concavo-convex sac-like transverse partitions which have the appearance of the tabulae of corals. These tabulae seem to be convex upward, or at least they occupy that position in specimens found embedded in an upright position in the strata. In sections, the centre of this tube is open and filled with transparent calcite, or often empty, while around this space, close to the wall of the tube, is an area with numerous incomplete tabulae or cystose diaphragms (Plate II, figures 1, 2; Plate IV, figures 2, 4). This central tube, therefore, corresponds to the whole section of *B. nodulosa* Billings, as shown by Nicholson in figures 2 and 3 of Plate VIII, of the publications cited above, but in *B. nodulosa* there is evidently much more of the cystose tissue than in the present species. This axial tube is nearly central in position in most of our specimens and is of variable diameter in proportion to the total diameter of the fossil. In one good section it is 3 mm. in diameter, and the total diameter is 14 mm. In another it is 5 mm. of a total diameter of 24 mm. In other forms it seems to occupy a much larger proportion, as in Plate I, figure 2.

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[1] Geol. Surv. of Canada, Rept. of Prog. for 1856, 1857, p. 343.

[2] Monograph British Stromatoporoids, Palæontographical Society, London, 1886, pp. 86-89, pl. 8, figs. 1-8.

Outside the axial tube there is a zone which in the best specimens is filled with clear calcite or is hollow, while in others it is filled with a very fine-grained brownish lime-mud containing more or less clear calcite. None of the sections show any trace of structure in this zone, and there is nothing to indicate that it ever contained any continuous skeletal structures, though it is very possible that at intervals it was crossed by some sort of supporting processes (See Plate II, figures 1 and 2; Plate IV, figures 2, et al).

The outer zone consists of a number of concentric sheaths traversed by radial canals. This structure is well shown in the best preserved of the specimens (Plate II, figures 1, 2).

The radial structure is well shown in several figures, particularly in Plates II and III. The appearance produced is that of the radial septa of corals. That these are not septa, but radial tubes with intervening pillars is, however, shown both by sections and by weathered specimens. For instance, figures

1, Plate III, and 1, Plate IV, in which the sections are not cut exactly perpendicular to the axis show wavy instead of straight lines, and a tangential section clearly shows the true nature of the structure (Plate III, figures 4, 5). In the weathered specimens the outer shell is frequently preserved, and the filling of the tubes weathered away, so as to reproduce almost exactly the original structure.

In only a single case have I found a specimen showing an end, and this specimen shows only one end (Plate I, figure 2). The specimen as now preserved is about 210 mm. long, and assuming that the natural position of the diaphragms is really convex upward, it shows the upper end of the specimen. The specimen enlarges into a sort of bulb at the top, both the inner tube and the outer sheath being enlarged. The specimen was originally weathered away about one-half at the lower end and apparently somewhat more than half at the bulbous end. Figure 2, Plate I, shows the specimen as it was found. This specimen, like the others, shows the inner tube to be entirely distinct from the outer sheaths, and where the specimen is weathered, a zone 2 mm. wide has weathered away, so that there is a narrow and deep trench on each side of the inner tube. The whole diameter of the specimen at the smaller end is 23 mm. and the tube is 13 mm. in diameter at this point. At the widest part of the bulb the whole specimen is 35 mm. across, and the bulb of the tube itself is 21 mm. wide. The specimen seems, at the bulb, to be cut down below the median plane so that these dimensions probably do not express the full size of the bulbous end. The outer sheath seems to consist of 4 or 5 thin layers and is most decidedly Stromatoporoid in appearance, even suggesting that it is an incrustation upon the inner tube. The sheath seems to have entirely enveloped the upper end, and sends out a curved portion of the sheath which extends some 20 mm. beyond the apex of the bulb. The presence of this sheath over the upper end of the organism effectually disposes of the idea that the animal could have been a coral.

The condition of preservation of the inner tube of this specimen is of some interest in connexion with the question of the possible nature of the organism. In the untapering part of the cylinder, the tabulae or diaphragms are mostly well preserved and apparently in their natural positions. In the enlarged, bulbous part, all of the diaphragms are broken and none extends across the full width of the bulb. This portion of the tube is filled with the same limestone in which the fossil is embedded, whereas, in the cylindrical part lower down, where the diaphragms are unbroken, the chambers are, generally, filled with crystalline calcite. Beginning at the bulbous end the inner tube shows, first, 4 mm. with cystose tissue, such as is seen around the inner part of the tube in some sections. Then 39 mm. in which all diaphragms are broken and the filling is like the matrix. Next, 20 mm. of clear calcite filling. Next, three unusually deep chambers (18 mm. in all) filled with limestone matrix. Then follow 33 mm. in which the diaphragms are rather close together (twelve chambers in the interval), and the filling material is all calcite. Next a single deep chamber (6 mm.), filled with matrix, then three (6 mm. in all) with calcite, one partially empty. Next two (9 mm.), empty except for a lining of calcite crystals. Then three (13 mm.), with clear calcite. Then a deep one partially filled with clear calcite and partially with matrix. The filling with limy mud seems to have taken place after the death of the organism and after it had fallen from its erect to a horizontal position. The chambers with unfractured walls and diaphragms were evidently cut off from the supply of mud, and the filling consists of such material as could be filtered in in solutions. The mud-filled parts must, on the other hand, have had openings by which rather coarse material could enter, and that these openings were accidental and not natural is indicated by the fact that the diaphragms or side walls are seen to be fractured in most cases. The supply of mud does not, however, seem to have entered directly from the outside to the chambers which it now fills, but has been conveyed along the "empty zone" surrounding the tube. This zone is filled with clay, and served to feed mud into the inner tube through any fractures which might be present. In most cases this zone is filled with clear calcite (as in figure 1, Plate III, and figures 1 and 2, Plate IV, for instance), but in such cases there is often another and outer zone mud-filled (figure 2, Plate IV). The explanation of these "empty" zones is not obvious. In no section so far cut does this zone show anything more than the vaguest trace of structure, and the only explanation which suggests itself to the writer is that the inner tube may have been entirely surrounded by a sheath of organic matter which depended for support on the calcareous walls on either side of it. The presence of this zone seems to militate against the idea of the outer sheaths being a separate organism parasitic upon the interior tube-like portion, for if the tube were entirely coated with organic matter, it would not be apt to attract a parasite which secreted a calcareous skeleton.

Judging from the nature of the upper end of the specimen just described, it would appear that the inner tube of this structure was not the habitation of an animal, otherwise the top would not have been enclosed. The one conception which appeals to the writer is to think of this as a colonial organism built up by numerous small polyps which secreted a skeleton at the base, the skeleton being, therefore, internal. The inner tube was a structure deposited as an axial support giving rigidity to the colony, and the zoids were on the exterior of the mass, and secreted the successive sheaths as they grew outward. The radial pores may have been the lodging places of the separate zoids, all of the pores being of the same size, and, therefore, no differentiation into gastropores and dactylopores as in Millepora.

This way of thinking of the organism also serves to explain the empty rings which are otherwise so puzzling. Among the Hydromedusae we have the order Tubulariae, in which a chitinous periderm is secreted. It is quite possible that the zoids of this early Palæozoic organism secreted a basal layer of calcareous matter and then surrounded themselves at the sides with chitinous material. The next generation founded their calcareous basement upon the chitinous layer of their progenitors, thus producing alternating bands of calcareous and chitinous material. After death, the calcareous material being much more resistant than the chitinous is preserved, while the more easily decomposed material is replaced by an infiltration of mud or crystalline calcite.

Owing to the slight development of the cystose tissue and the great development of the sheath zone in the form unde consideration, it does not seem proper to refer it to *Beatricea* and the following new generic name is, therefore, proposed.

Genus CRYPTOPHRAGMUS *nov.*

(*Kryptos, concealed: phragmos, partition.*)

Colonial organisms, presumably Hydromedusae, of elongate, upright, unbranched form, small diameter, and slight taper. Skeleton consisting of internal camerate tube with distinct wall, the tube crossed by irregularly spaced partitions which are convex upward, and further strengthened by a deposit of incomplete partitions (cystose material) on the inner side of the wall of the tube. The inner tube enveloped by concentric, often slightly separated sheaths of calcareous material, the sheaths traversed by numerous circular openings at right angles to the long axis of the colony. The sheaths extend over the upper end of the inner tube, which may be enlarged and bulb-like. Type, *Cryptophragmus antiquatus* sp. nov.

CRYPTOPHRAGMUS ANTIQUATUS *sp. nov.*

Plates I-IV.

Since I have not differentiated the rather numerous varieties that are found in the locality at Carden, the generic description will serve also for the species. Should Ulrich's *Beatricea gracilis* prove to belong to this genus, it may be necessary to enter into the question of specific characters. At present, *Beatricea gracilis* has the status of *nomen nudum*. It may be possible to differentiate species on the basis of the relation of the diameter of the inner tube or support to the total diameter of the colony, in which case the specimens figured on Plate I, figure 2, would not belong to the same species as those shown in figures 3 and 4, Plate I, and 1 and 2, Plate II. In view of this contingency, I have designated the specimens with the large tubes as the types of the species *C. antiquatus*, and, in particular, would designate the most complete specimen Plate I, figure 1, as the holotype of the species.

Some of the specimens have the axial tube 15 mm. in diameter and one such has the clear band 2·5 mm. wide. The presence of this structureless "clear zone" explains the state of preservation of most of the specimens found on the weathered surfaces of the rocks. It being either hollow or filled with a soft substance, the outer sheath zone and the axial tube were easily separated, and in the specimens usually found such separation had occurred before the specimens were buried in the rocks.

Summary. Transverse sections of *Crytophragmus antiquatus* show that it is composed of three distinctly separated and well marked concentric layers. The inner axial tube has a large cavity, divided into chambers by bulging partitions, and around this cavity is a narrow band of cystose tissue, without radial elements of any kind. The axial tube has a well-defined outer wall, and is surrounded by the second zone which seems to be structureless and is usually marked by a band of clear calcite. The outer zone is composed of concentric sheaths traversed by numerous radial canals.

Comparison with *Beatricea nodulosa* and *B. undualata*.

The skeleton of this species has a much smaller habit than either of Billing's species and the surface is evidently much more nearly smooth. As to the internal structure, as revealed by thin transverse sections, there seem to be rather striking differences. A distinct differentiation into three zones exactly comparable to those described above has not been noted by students of the above species. As noted above, the sections given by Nicholson in figures 2 and 3 of Plate VIII of his article do not appear to represent a section of a complete skeleton, as Nicholson supposed, but are comparable to the axial tube of *Cryptophragmus antiquatus*. If this latter comparison is correct, then the central tabulate zone of *B. nodulosa* is very small as compared with that in the axial tube of *B. antiquata*, and the surrounding cystose zone very thick. In *C. antiquatus* there are no indications of radial elements in the cystose zone, nor are there anywhere the granular deposits on the walls, such as both Nicholson and Parks have described. As seen in this section the walls are perfectly sharp, and though each wall has a cloudy border, this border, as seen under a high power, seems to be due to alter-

ation products of the wall distributed along minute crack
the calcite which fills the cells.

While descriptions of *Beatricea nodulosa* and *B. undulata*
not specifically describe the three zones, yet an inspection of
macroscopic character of specimens from Anticosti shows t
both the outer or "sheath" zone and the axial tube are pres
in well preserved specimens, and certain of them indicate
presence of a "clear" zone as well. Parks, in his "Ordovici
Stromatoporoids,"[1] thus describes a section of *B. undula*
which, unfortunately, he does not figure: "This specimen is
mm. thick and presents in cross section a series of concent
layers of very different aspect. The inner tube has a radius of on
3 mm. This is surrounded by a ring, 20 mm. thick, of ordina
vesicular tissue with the granular element well developed, b
with scarcely a trace of radial pillars. Surrounding this rin
is an outer zone, 15 mm. thick, which is fairly well demarke
by a sharp line of separation. This outer layer is strikingl
different from the middle annulus, being composed of continuou
laminae and well marked radial pillars."

Parks does not state that his inner tube, only 3 mm. i
radius, has a distinct wall, and as he copies Nicholson's figures
where such a wall is absent, we are inclined to think that both
his inner tube and the 20 mm. thick band of vesicular tissue
around it are to be correlated with the "inner tube" of *C. antiquatus*. The outer band is probably the same as our "sheath" zone, and there is apparently no "clear" zone present.

Some of Nicholson's sections seem to have been cut from the "sheath" zone of *B. nodulosa*, for he states in a footnote that in one section he noticed perpendicular calcareous septa crossing the vesicles. The relation of the present form to *Beatricea* is now being studied by the writer, and will probably be set forth in a later paper.

The photographs which illustrate this article were, with the exception of figure 2, Plate I, made at the Geological Survey of Canada and all the types are in the collections of this Survey. Except where otherwise noted, the specimens are from the locality in Carden.

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[1] Univ. of Toronto Studies, Geological Series, No. 7, p. 44, 1910.

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EXPLANATION OF PLATE I.

Cryptophragmus antiquatus Raymond.

Figure 1. Fragment of a specimen from which only a part of the outer sheath
have been removed by weathering. In places where the specime
is broken the transverse partitions may be seen. The figure i
in a reversed position, up side down. About natural size.

" 2. A photograph of the only specimen so far found preserving a termination
The bulb-like enlargement of the upper end is shown, also the
curved extension of the outer sheath above. (Indicated by arrow).
Notice the calcite-filled chambers (A), the empty ones (B), and
those filled with lime-mud (C). Six-tenths natural size.

" 3. Photograph of polished longitudinal section showing inner tube with
convex partitions, the "clear zone" near the tube, and the sheaths
outside. Natural size.

" 4. The upper, naturally weathered end of the same specimen, enlarged.
Notice the differential weathering, and the faintly indicated
radial tubes of the sheaths.

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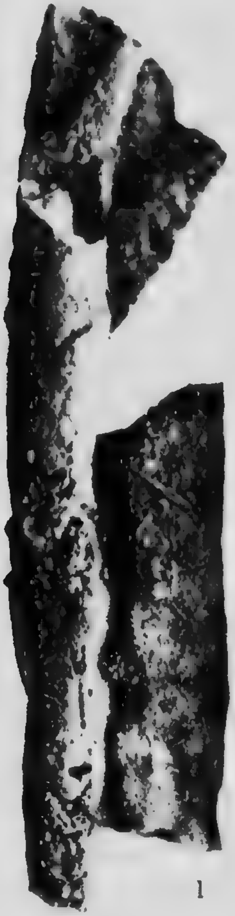

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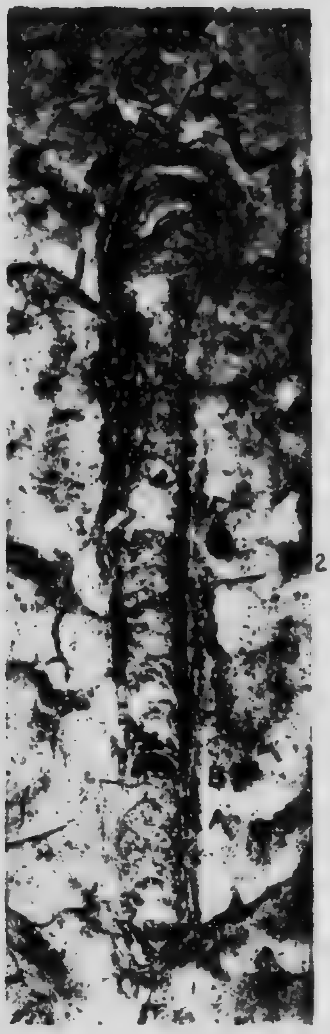

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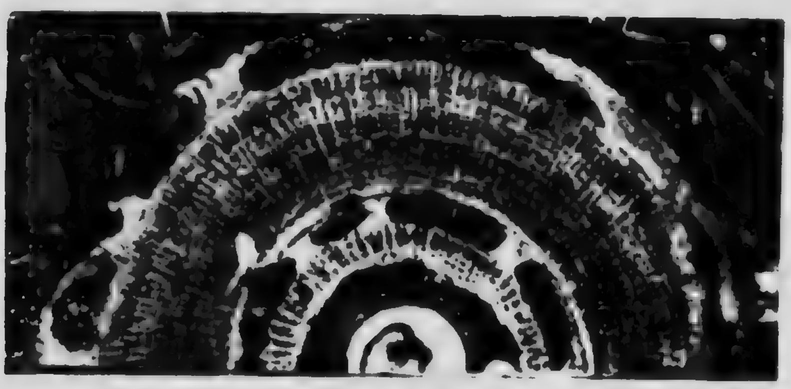
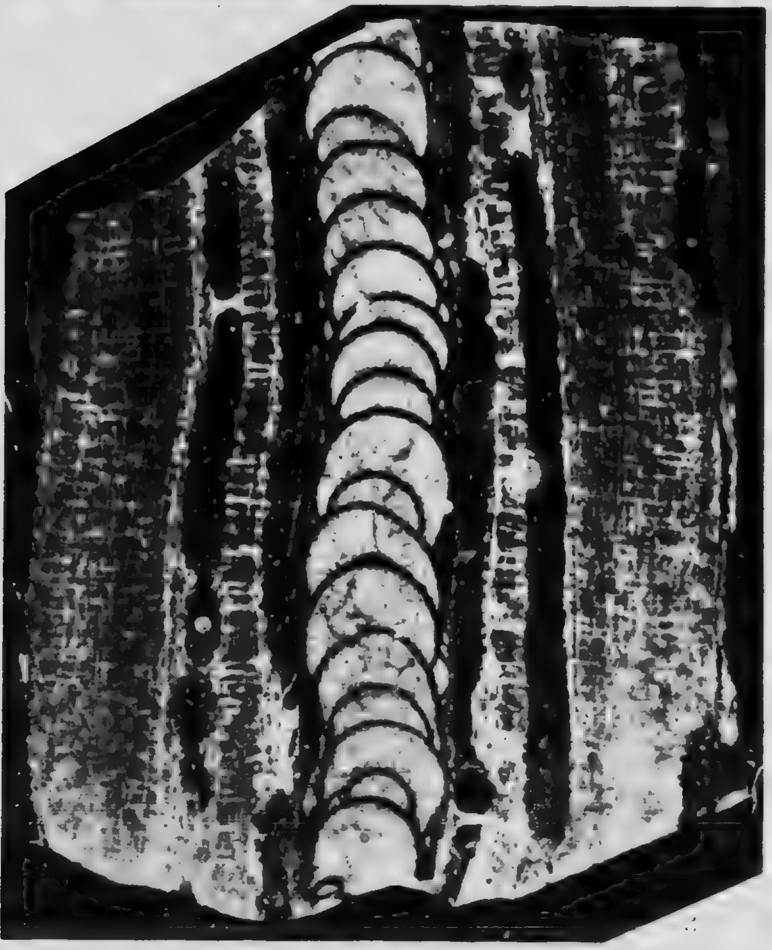
EXPLANATION OF PLATE II.

Cryptophragmus antiquatus Raymond.

Figures 1 and 2. Transverse and longitudinal thin sections of a specimen,
larged 4 diameters. Note the inner tube with its convex partitio
and wall of vesicular tissue, the alternation of well preserve
and lime-filled zones, and the radial tubes. For other section
of this same specimen, see Plate III, figures 4 and 5





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EXPLANATION OF PLATE III.

Cryptophragmus antiquatus Raymond.

Figure 1. A somewhat diagonal transverse thin section, showing the cent
tube with its vesicular wall, the cross-section of the partitio
and the radial tubes of the outer sheath zone. Between the tu
wall and the sheath zone is an area of calcite in which the cryst
are coated with a brown substance, thus producing, in the phot
graph, an appearance of structure in the "clear zone." Enlarg
3 diameters.

" 2. A specimen from near Ottawa, showing the somewhat abrupt cur
ature of some specimens. From the top of the Pamelia, 2 mil
north of Aylmer, Que. Natural size.

" 3. Transverse section just at the top of one of the convex partition
the dark circle at the centre being the top. Just what the meanin
of the structures seen in this section may be has not been deter
mined. X 3.

" 4. Tangential section of the specimen shown in Plate II, showing th
exceedingly numerous tubes in the sheath. X 3

" 5. Section similar to figure 4, and from the same specimen, but no
strictly tangential. At the centre it cuts into one of the structure
less zones. X 3.

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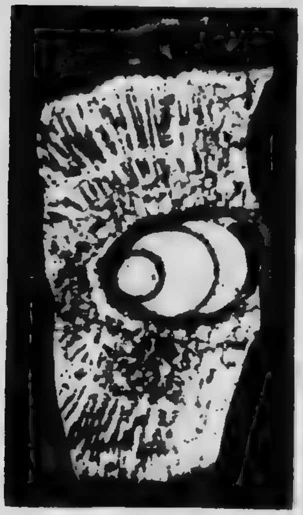

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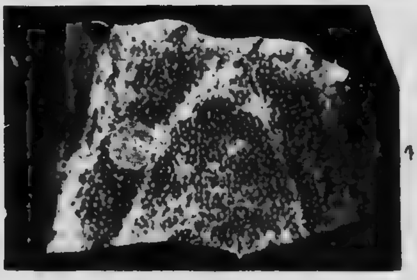

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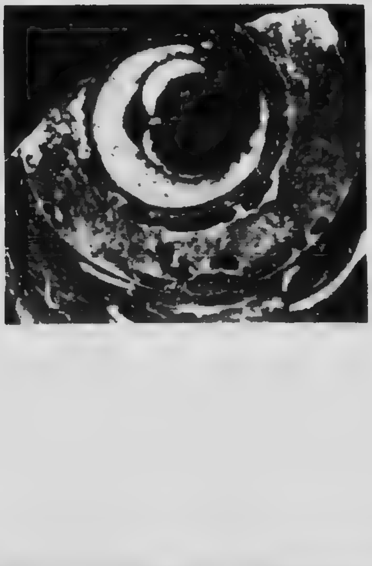

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EXPLANATION OF PLATE IV

Cryptophragmus antiquatus Raymond.

Figure 1. A transverse section, not at right angles to the axis. X 3.
" 2 A transverse section at right angles to the axis, shows the inner
with definite wall, a "clear zone," then a pore-pierced sheath
a lime-mud filled structureless zone, and finally an outer
zone. Notice the papillate nature of the outer surface where
specimen is still in contact with the matrix, and note that
elevations are at the apertures of the tubes, and not at the
walls. Also that the tubes are filled with calcite and not
mud. X 3.
" 3. A rather badly preserved transverse section. X 3.
" 4 A transverse section in which the vesicular wall of the inner
is especially well preserved. X 3.
" 5. A specimen in which the inner tube only is preserved, the
being entirely destroyed. Such specimens are very
found. ¾ natural size.

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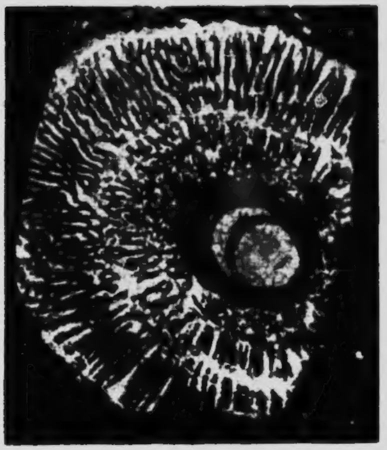

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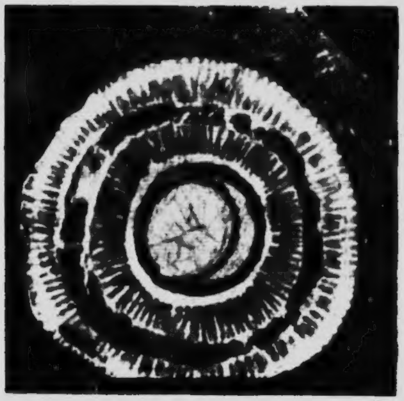

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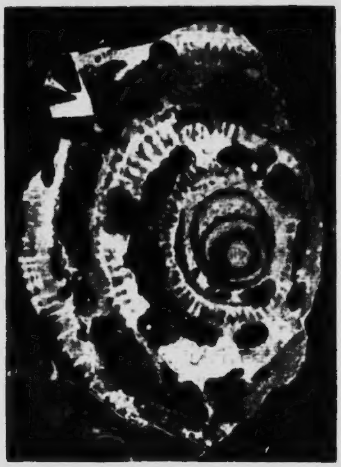

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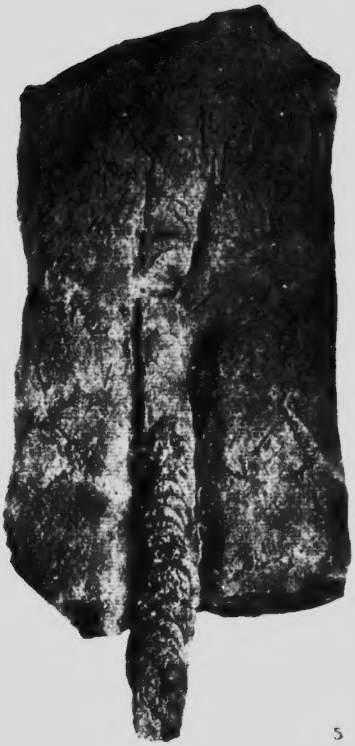

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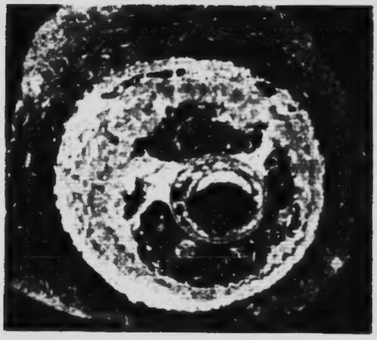

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The first number of the Museum Bulletin was entitled, *Victoria Memorial Museum Bulletin Number 1*.

The following articles of the Geological Series of Museum Bulletins have been issued.

Geological Series.

1. The Trenton crinoid, Ottawacrinus, W. R. Billings; by F. A. Bather.
2. Note on Merocrinus, Walcott; by F. A. Bather.
3. The occurrence of Helodont teeth at Roche Miette and vicinity, Alberta; by L. M. Lambe.
4. Notes on Cyclocystoides; by P. E. Raymond.
5. Notes on some new and old Trilobites in the Victoria Memorial Museum; by P. E. Raymond.
6. Description of some new Asaphidæ; by P. E. Raymond.
7. Two new species of Tetradium; by P. E. Raymond.
8. Revision of the species which have been referred to the genus Bathyurus (preliminary paper); by P. E. Raymond.
9. A new Brachiopod from the base of the Utica; by A. E. Wilson.
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20. The Crowsnest Volcanics; by J. D. Mackenzie.